5000, 20,000, 40,000, or more impulses per second. He rightly says we have no experimental evidence that a nerve can convey at the utmost more than 500 impulses per second. He quotes the investigations of the late Dr. Keith Lucas, but Keith Lucas was careful to point out ("The Conduction of the Nerve Impulse") that his work had been necessarily confined to the motor nerves of muscles, and was clearly of the opinion that his results were not transferable to sensory nerves, particularly in the case of light and sound." Indeed, on Helmholtz's theory we infer, and are justified in the inference, that certain fibres of the auditory nerve must be capable of carrying at least 18,000 impulses per second—if we accept that number as the upper limit of our range of hearing. In Sir Thomas Wrightson's theory it is necessary to presume that every hair-cell is capable of generating, and every auditory fibre of conducting, at a rate which may vary from 60 per second to 80,000 per second. I anticipate that the internal ear will provide psychologists with the most delicate means of investigating the manner in which sensory stimuli are produced by mechanical means.

Instead of Helmholtz's theory being in conformity with Müller's law, and Sir Thomas Wrightson's at variance with it, I am of opinion that the opposite is the case. In consequence of having adopted the theory of resonators, Helmholtz had to make the further assumption that the auditory differed from every other sensory nerve—such as those of touch, taste, and smell—in that its fibres were specialised into 15,000 or more units or groups, whereas in ordinary sensory nerves there is no such specialisation, every one of its fibres being capable of serving the same kind of function. The only exception is the optic nerve, in which Young and Helmholtz postulated at least three kinds of units or fibres. The recent investigations of Dr. F. W. Edridge-Green and of Dr. R. A. Houston tend to prove that there is no need to postulate a functional differentiation in the fibres of the optic nerve, and similarly the Wrightson theory does away with the necessity for presuming that the auditory nerve contains 15,000 sets of fibres which are functionally distinct.

No reference was made by Sir Thomas Wrightson to experiments which had demonstrated that animals subjected to a prolonged repetition of a note of a high vibrational frequency suffer a degeneration at the narrow, proximal or fenestral end of the organ of Gorti—just the area which we may presume would be affected if the theory of Helmholtz were true. Nor was allusion made to the less certain results obtained at the opposite end of the organ by prolonged repetition of notes of low frequency. From the measurements and data which I placed before Sir Thomas Wrightson, he estimates that in all stapedial movements pressure falls simultaneously and equally on all parts of the basilar membrane, but of this I am not convinced, conceiving that notes of high frequency, especially where the waves rise sharply to their maximum intensity, will fall chiefly on the proximal or narrow end of the basilar membrane, whereas notes of low frequency, rising slowly to their maxima, will fall chiefly on the distal or wide end of the membrane. If such is the case, then it is not necessary to invoke Helmholtz's theory for their explanation. The explanation is not a new one, having been put forward by Prof. Max Meyer, of the University of Missouri, a number of years ago.

There are also the cases observed by aural surgeons where tone-gaps or islands occur in the gamut of hearing. These cases receive an apparent explanation on the Helmholtz theory. I think it will be found that such cases represent defects in the auditory system corresponding with colour-blindness in the visual system, both representing disorders, not in the peripheral, but in the central, parts of the auditory and visual systems. I would direct particular attention to a statement made by the late Keith Lucas on the last page (p. 102) of his posthumous work on "The Conduction of the Nervous Impulse":—"*On the basis of this analysis we have pictured the central nervous system as a network of conductors having different refractory periods, communicating through regions of decrement, easily fatigued.*" A network of conductors having different refractory periods presents the exact mechanism needed for the sorting out of the millions of impulses which reach the auditory centres along the fibres of the auditory nerve. Sir Thomas Wrightson has shown that, however complex the sound, each component part is registered by the hair-cells as the complex passes through the inner ear. Keith Lucas's speculations open up the possibility of a central machine for assorting the impulses according to their time-intervals.

I, for one, am particularly glad that Prof. Bayliss has taken an interest in this matter, because his knowledge of that borderland which lies between physics and physiology peculiarly fits him to adjudicate on the claims of the Helmholtz and of the Wrightson theories of the internal ear. A. KEITH.

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Epidemic Influenza.

PROF. HEWLETT's interesting article in NATURE for October 24 may justify the statement of a few facts collected during the last quarter of a century. Dealing with the Registrar-General's returns for London and considering twenty deaths per week as epidemic if this number or more is maintained for successive weeks, there have been twenty-eight epidemics since the reassertion of the complaint in 1890. Of these there have only been two, in the years 1910 and 1911, with fewer deaths than 100. The only years in the epoch without influenza being epidemic are 1896 and 1901. The most serious epidemics since 1890 occurred in 1891, 1892, and 1899–1900, in each of which there were in London upwards of 2000 deaths. In recent years the most serious epidemic occurred in 1908 with a total of 1061 deaths, but the summer and autumn epidemics of the present year bid fair to be at least as severe.

The two epidemics of the present year differ very materially from all the other epidemics since 1890 with respect to the age-death. The Registrar-General has introduced a slight change in the returns from 1911, which prevents 40 being uniformly adopted as an age limit for death. Taking all the epidemics from 1890 to 1916–17, the deaths at ages from 0 to 20 years were 12 per cent. of the total number; from 20 to 40 or 45 years, 14 per cent.; and from 40 or 45 years and upwards 74 per cent. These numbers are remarkably similar in the several epidemics. For the two epidemics this year the deaths for the respective ages are 0 to 20 years, 26 per cent.; 20 to 45 years, 48 per cent.; and above 45 years, 26 per cent. It is an interesting problem to account for the difference introduced in the ages of death in the epidemics of the present year.

Prof. Hewlett refers to the disease waning and almost disappearing after the epidemic of 1893–94, but an examination of the Registrar-General's returns will show that the epidemics were exceptionally severe in 1895, 1899, and 1899–1900, and also in 1008, the deaths in London from influenza alone exceeding

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1000 in each of these attacks. The year 1891 is referred to as the worst period, but at the date mentioned the Registrar-General says "one death was primarily attributed to influenza." In lieu of 1891 the year 1892 should have been given, when for the week ending January 23 the deaths in London were 506. The quiescence of the disease lasting three-and-twenty years is scarcely tenable, as shown by the above facts.

The total number of deaths from influenza for the past summer epidemic was 929 (not 1600), based on the reasoning followed in all epidemics since 1890. In the attack now in progress the total deaths (371) in London for the week ending October 19 were more than in any epidemic since 1895, when the deaths in the week ending March 19 were 473.

Since 1890 no influenza epidemic has occurred in London in September, only one (the present year) in August, two in October, two in July, three in June, and four in November. Of the total twenty-eight epidemics twenty-four have occurred in March and twenty-one in February.

Although the weather seems to have little bearing on the disease, the temperature generally has been abnormally high and the air humid at the outbreak of several of the epidemics, whilst when the air becomes cold and dry the incidence of the disease is commonly reduced.

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Supplies of Amœba proteus for Laboratories.

One of the ways in which the war has interfered with zoological teaching in this country is by cutting off supplies of various of the animal types which are examined by the student in the laboratory. Amongst these, as has already been indicated by letters to Nature, is Amœba—the animal with the study of which many zoological courses commence.

It is easy enough to obtain Amœbæ of a kind, but what the teacher requires is a supply of the large Amœba which commonly goes under the name *A, proteus*. Of this, again, it is easy enough to obtain a few specimens, but the teacher—at least, if he has a class of nearly four hundred students, as is the case in this University—must be able to obtain a thousand or more specimens on a particular date.

With the object of grappling with our local difficulties in this matter, Dr. Monica Taylor, S.N.D., has been so good as to make a special study of the distribution of *A. proteus* in the neighbourhood of Glasgow, and of its culture in the laboratory. Pending the publication of her paper on the subject, I think it may be useful to other teachers of zoology if I summarise in a few words her chief results.

During the months June to December *A. proteus* seems to be of general occurrence in moorland lakes and ponds, while it disappears from December to May—no doubt becoming encysted, as described by Miss L. Carter (Proc. Roy. Phys. Soc. Edin., vol. xix., 1915). The main conditioning factors of its occurrence appear to be abundant food supply and a rich supply of oxygen. An apparently ideal spot is one where richly oxygenated water from the overflow of a pond passes over mud rich in organic *débris*.

The supplies of Amœba obtained in such a locality are placed in aquaria in which the water is richly aerated either by water-weed or by a special apparatus, and as a source of food supply grains of wheat are mixed with the mud, as suggested by Hyman. In this way Dr. Taylor has succeeded, as she says, in obtaining "millions" of Amœbæ in laboratory cultures.

J. Graham Kerr.

University of Glasgow, October 22.

ALCOHOL IN INDUSTRY.

Not the least remarkable result of the war on this country will be its effect on the development of chemical industry, and especially in the application of organic chemistry to the chemical arts. This, of course, has primarily resulted from the cutting off of the large supplies of manufactured organic products—mainly synthetic dyes and drugs, photographic chemicals, and numerous other substances comprehended under the term "fine chemicals"—which prior to 1914 mainly came to us from Germany. Thrown thus upon our own resources, we were compelled, in the interests of national health and welfare, to attempt the manufacture of certain of the more important of these products. Great difficulties were experienced at the outset, owing to our lack of experience and the absence of skilled assistance. The supply of chemists with any real training in the application of organic chemistry to industry was very far short of the sudden demand. We were overtaken by a Nemesis invoked by our own inactivity and lack of foresight. It is only within recent years that the teaching of organic chemistry has received any considerable amount of attention in our universities and technical colleges. For the most part it has been regarded as a purely academic subject, to be studied in the interests of pure science, and with no thought to its technical application as a branch of manufacturing chemistry. Except to the few who sought to fit themselves for a career in science, mainly as teachers, there was little or no inducement to pursue its study, as there were very few opportunities in this country to turn a knowledge of it to practical account.

The situation at the outbreak of war was further aggravated by the action of the Army authorities in drafting such trained men as were available into the combatant ranks. But, notwithstanding these disadvantageous circumstances, an astonishing amount of progress has been made. As regards medicaments our manufacturers have risen to the demands made upon them. In spite of many setbacks due to inexperience and ignorance, and the lack of adequate plant, we have it on the testimony of the highest authorities that the Services are now adequately supplied with every needful drug. In this respect our men, and the country generally, are infinitely better off than our enemies. It is notorious that Germany, in spite of all her boasted power of organisation, has failed lamentably in meeting the necessities of her Medical Service, and an untold amount of suffering, permanent injury, and a greatly increased mortality have thereby resulted.

As regards synthetic dyes, if the progress has not been relatively so striking or so adequate as in the case of drugs, it has at least been very considerable. We are very far from being alongside Germany yet, either in the amount or the range of our output, but we are in a fair way of being able to meet our more urgent demands. It is impossible in five years to make up the leeway of fifty, especially of fifty years of strenuous and

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